Saskatchewan Technology Enhancement Program

Field Measurements Using Thematic Mapper Data In The Swift Current Area, Saskatchewan

by

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Saskatchewan Crop Insurance Corporation
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SRC Technical Report No. 201
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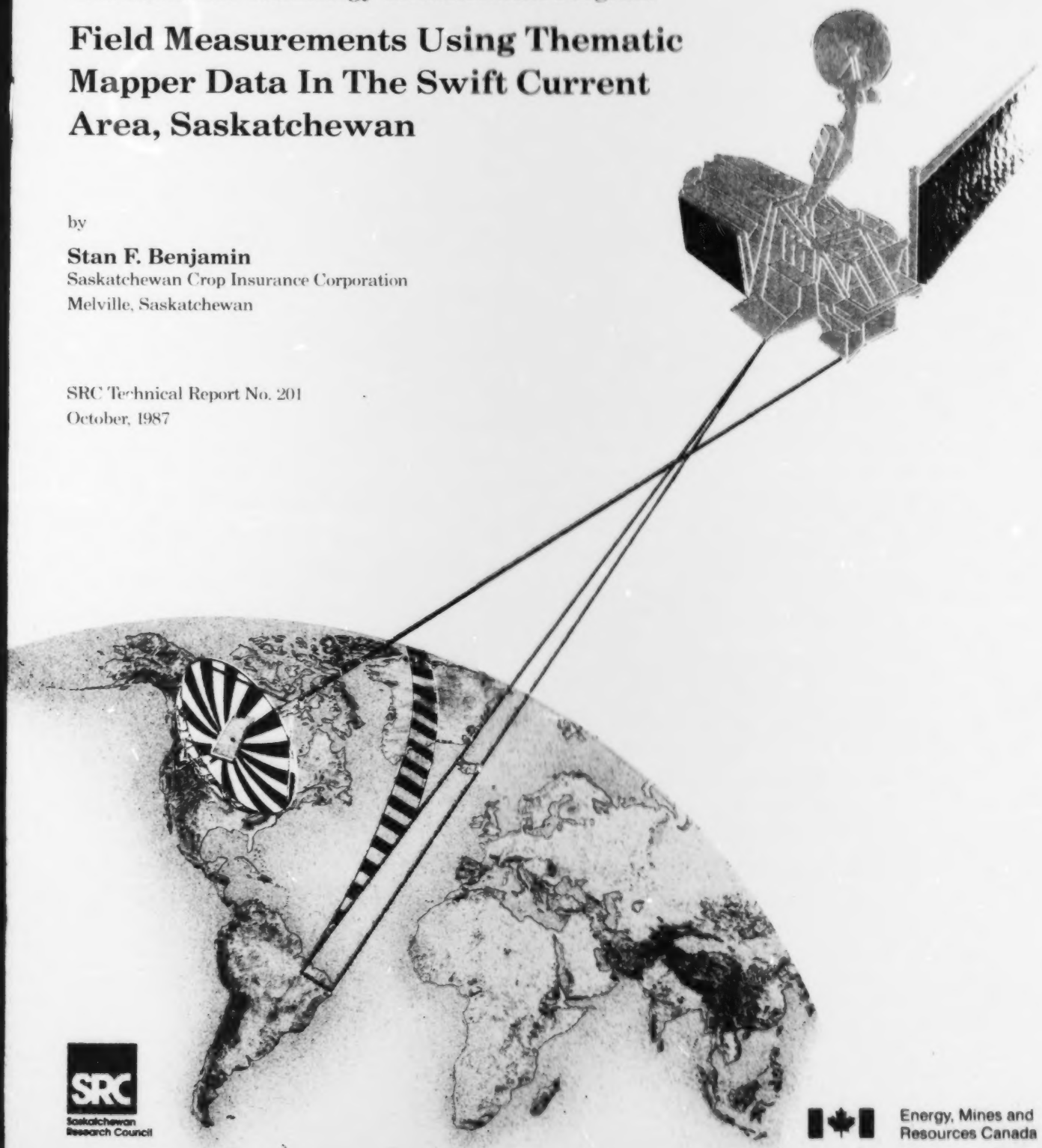

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Figure 2. Supervised Classification in the Swift Current area with three classes.

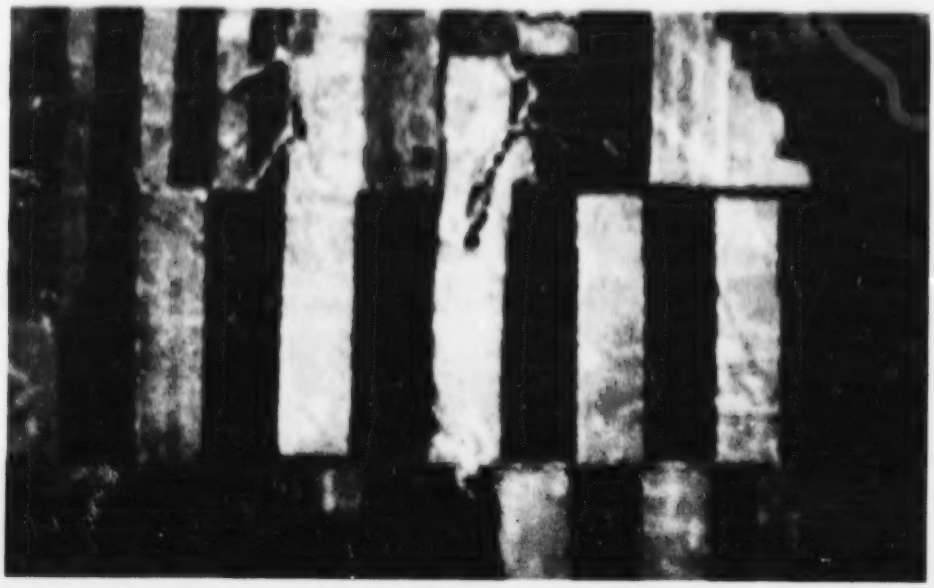

Figure 3. Filtered Supervised Classification of the Swift Current Area With Three Classes.

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1. Two thematic map images for analysis.
2. Photographic blowups of the project area.
3. A one week training course for two people.
4. Help with project planning and data requirements.
5. Analysis time for visual interpretation.

1. INTRODUCTION

The Saskatchewan Crop Insurance Corporation offers protection against loss of crop production due to natural hazards to farmers in Saskatchewan. Contract holders are guaranteed a level of crop production per acre for all acres seeded to a particular crop. The provincial government pays the administration costs and the dollar premium/acre is paid 50% by the farmer and 50% by the federal government.

The basic insurance works as follows:

- The producer purchases a contract which guarantees a quantity and quality of production and a guaranteed price for bushels or kilograms lost.
- For all crops selected, the insured (producer) must submit a seeded acreage report where he details the crop seeded by quarter section, acres seeded and if on summerfallow or stubble land.
- After harvest, if the insured feels he has harvested less than he is guaranteed, he submits a request for a claim adjustment to the Corporation.
- A field person then visits the producer's farm to record the amount of grain produced and measures the acreage of seeded crops. Using the acreage estimates provided by the insured, the field person measures the fields with a "wheel" which the field person "walks" around the perimeter of the field. If the first field measured is within 5% of the estimate from the seeded acreage report, then the field person can use the estimates of the next five fields then measure the sixth.

In the past, aerial photographs have been used to estimate acreages of fields that were difficult to measure because of boundaries which were not square and were difficult to measure with a wheel. Because aerial photographs are not obtained annually, the boundaries in the year of the photograph can be different than the year in question. Therefore, only the amount of cultivated land can be determined.

If a yearly data base of field boundaries by quarter section could be established, then measuring fields by ground survey could be eliminated or greatly reduced. These measurements would have to be 95% accurate and the time window would be restricted to July 15 to August 5.

2. OBJECTIVES

The objective of this project was to confirm the feasibility and cost effectiveness of using satellite data to measure field sizes. A method was to be developed using the Swift Current data and then apply that method to the data of the Qu'Appelle lakes.

3. STUDY AREA

Two study areas were chosen; one north of Swift Current with large rectangular fields and low acreage of unusable land; the other north of the Qu'Appelle lakes with smaller fields and large acreages of unusable land (Figure 1).

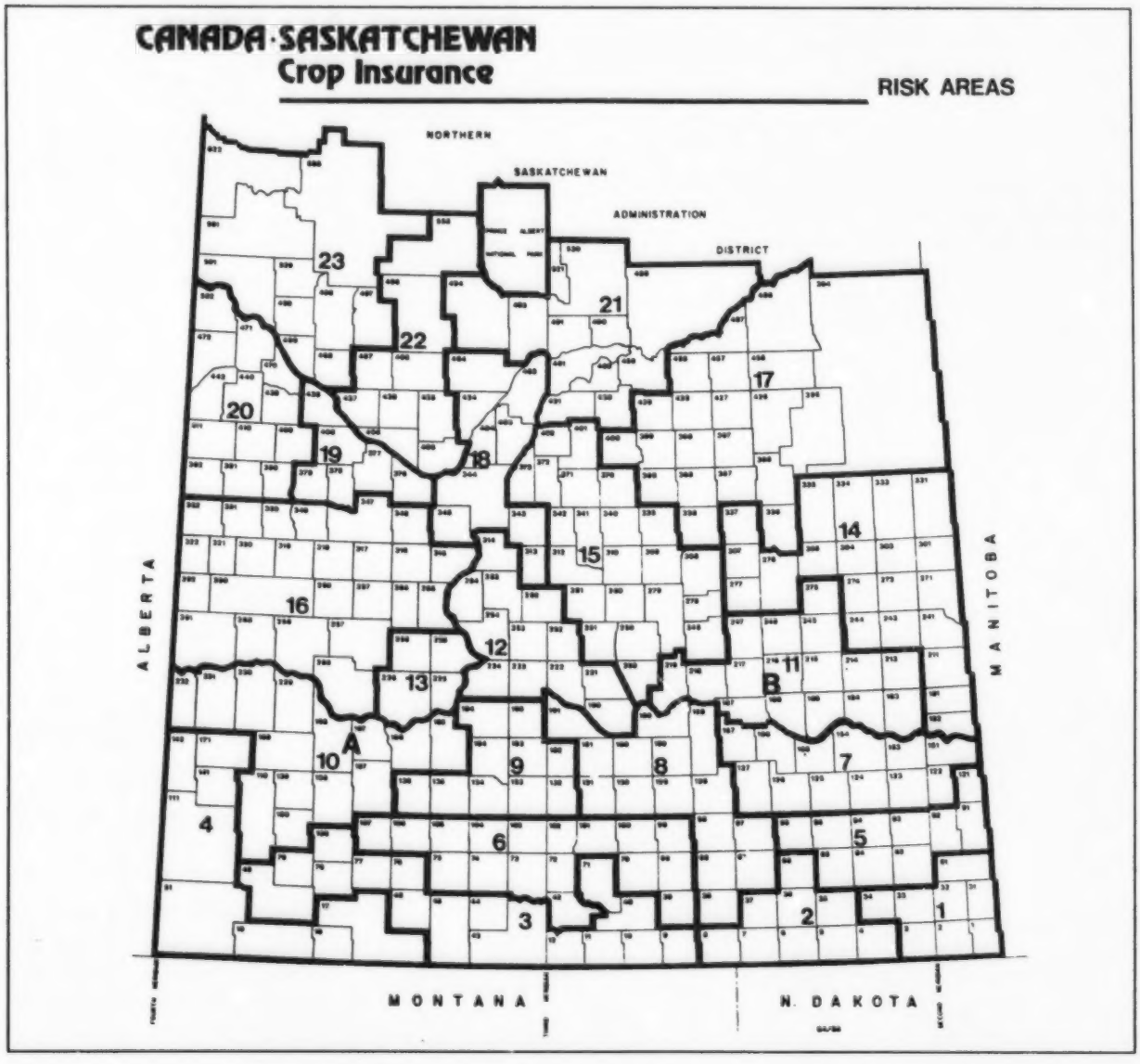

Figure 1. Location of the Two Study Areas: Swift Current (A) and the Qu'Appelle Lakes (B) Areas in Southern Saskatchewan.

4. METHODS

4.1 Data Acquisition

Two thematic mapper (TM) images, in computer compatible tape (CCT) format both dating from July 1984, were used for the visual and digital analysis of the Swift Current and the Qu'Appelle lakes areas.

4.2 Analysis

The Swift Current and Qu'Appelle Lakes images were geometrically corrected prior to performing any classification and enhancement procedures in order to more easily locate training areas and correlate the images to topographic maps. The geometric correction procedure involved the location of ground control points on 1:50,000 scale topographic maps in relation to their Universal Transverse Mercator (UTM) coordinates and locating the same points on the satellite image. A good distribution of points over the entire image enabled the operator to correct the image to less than half a pixel. Pixels were resampled to 20 x 20 m. Road, railway and river intersections were mainly used as ground control points.

Linear, logarithmic, histogram equalization, ratioing, and principal component enhancements were produced in order to separate crop types and enhance field boundaries. The best enhancements were then used in the classification procedures. The best enhancements were also visually analyzed.

The classified data were filtered to improve the accuracy.

5. RESULTS AND DISCUSSION

Excellent visual images were produced using the enhancement procedures of 1986 fields on which farmers were making claims and which had been difficult to measure on the ground. In the Qu'Appelle Lakes area, field boundaries were drawn on the imagery and field acreages determined using grid measurements by quarter section (Table 1). The same method was used for the Swift Current area. The enhancements improved the distinction between spring seeded crops and fall seeded crops as well as between improved grassland and native grassland. Large square fields produced an accuracy of over 95% while the small fields were below 80% accuracy.

The Swift Current area was classified using the supervised approach into three classes: native grassland, summerfallow and cropland (Figure 2 - frontispiece). Large areas were left unclassified along field boundaries. More training areas were then added to improve the classification. In areas with small fields, grassland edge confusion occurred between the three classes. For large square fields an accuracy level of over 90% was achieved but a number of the smaller fields were lost in the process (Figure 3-frontispiece).

The initial unsupervised classification of the Swift Current area produced 24 classes which were then recombined into six main classes:

1. Spring seeded cropland.
2. Summerfallow.
3. Native grassland.
4. Improved grassland.
5. Fall seeded cropland.
6. Roads and urban areas.

The unsupervised classification had excellent separation between spring seeded and fall seeded crops as well as between improved

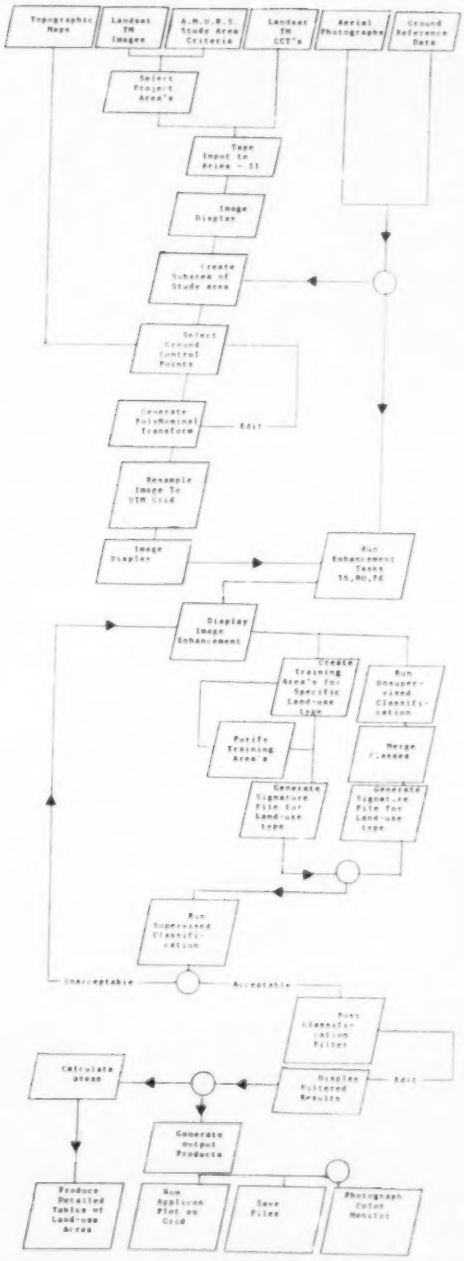

Table 1. Flowchart of Image Analyses Procedures used.

Table 2.

COMPARISON BETWEEN SATELLITE DATA AND GROUND DATA

A.M.U.R.S. PROJECT - 1984 - SWIFT CURRENT

MEASUREMENT ESTIMATE

SITE LOCATION = RM 137 TWP-15-RGE-15-MER.-W

Field	Sec	Qrt	Crop	Estimated # of Acres SMF	STB	Computer Analysis	Visual Analysis	Percent Match (0= Field not classified, 100= Exact acres)
1	2	SE	Barley		35	33	NA	106
2	2	NW	Barley		1	NA	NA	0
3	2	NE	Barley		14	13	NA	108
4	3	SE	Barley		1	NA	NA	0
5	6	NW	Durum Wheat	65	15	74	NA	108
6	7	SE	Durum Wheat	50		49	NA	102
7	9	NE	Fall Rye	80		84	NA	95
8	10	SE	Fall Rye	15		14	NA	107
9	10	SE	Barley	5	2	9	NA	78
10	10	SW	Barley	10		15	NA	67
11	10	SW	Fall Rye	70		60	NA	117
12	10	NW	Spring Wheat	55		60	NA	92
13	10	NW	Fall Rye	25		17	NA	147
14	10	NE	Barley		4	NA	NA	0
15	11	SE	Barley	12		12	NA	100
16	11	SW	Barley	4		NA	NA	0
17	13	SE	Fall Rye	15		15	NA	100
18	13	SW	fALL rYE	40		40	NA	100
19	13	NW	Barley		160	162	NA	99
20	16	SE	Barley		9	12	NA	75
21	16	SE	Spring Wheat	50		55	NA	91
22	16	NW	Durum	2		NA	NA	0
23	17	SE	Spring Wheat	60		59	NA	102
24	17	NW	Spring Wheat	40		40	NA	100
25	17	NE	Spring	80		79	NA	101
							Average Match	79.75

1986 - QU'APLLE LAKES

SITE LOCATION = RM 156 TWP-19-RGE-12-MER.-W2

Field	Sec	Qrt	Crop	Estimated # of Acres SMF	STB	Field Measured	Computer Analysis	Visual Analysis	Percent Difference Field Measured/ Estimated	Field Measured/ Visual Analysis
1	31	NE	Spring Wheat		70	111	NA	140	63.06	79.29
2	31	SE	Spring Wheat		160	156	NA	160	102.56	97.50
3	32	NW	Spring Wheat		106	111	NA	100	95.50	111.00
4	5	NW	Spring Wheat	60	54	95	NA	100	120.00	95.00
5	5	SW	Spring Wheat	60	90	38	NA	38	394.74	100.00
							Average Match		155.17	96.56

grassland and native grassland. The classified image was used to make field measurements and compared to the ground data. The results indicated an accuracy of over 90% for large square fields. There was some improvement of accuracy for the small fields but the average was still below 80% of actual acreages reported.

The overall accuracy level of the classified image as compared to field data was only 80%. This was confirmed by producing detailed statistical data on one township, plotting the data and making measurements with a grid. The data were then compared to declared acreages (by the farmers) from insurance fields (Table 2).

6. COST BENEFIT

The following costs were incurred during the duration of the demonstration project:

1. Research technician - 53 days over 2 years	$6,200.00
• training	
• planning	
• ground data acquisition	
• analysis	
• verification	
• documentation	
2. Computer programer	300.00
• data acquisition from files of insured acreages	
3. Field person	200.00
• measuring fields	
4. Travel expenses	2,000.00
5. Miscellaneous	200.00
Total	**$8,900.00**

Since no suitable data were entered into the crop insurance data base, no cost comparison in relation to traditional method was done. It was believed that the traditional method of manual field measurements on the ground are less expensive than via remotely sensed data. However, remotely sensed data can provide additional information and therefore would be more cost effective.

7. CONCLUSIONS AND RECOMMENDATIONS

As a result of this demonstration project the Saskatchewan Crop Insurance considers remote sensing as a useful method to be applied to short- and long-term planning and data gathering requirements for the following data types:

1. Field boundaries.
2. Crop types.
3. Crop condition.
4. Mapping areas affected by drought.
5. Areas affected by severe weather (hail, tornados, wind, snow, frost, flooding, etc.).
6. Vegetation types.

This data would be part of crop yield prediction model to be made in the future.

The results of the project were lower than expected (95%) but they could be adjusted with a regression curve to account for the error of the field boundary. It is therefore recommended that a regression estimator be used as well as more detailed analysis of TM data for field boundary delineation.

The Technology Enhancement Program (TEP) created an excellent learning environment, but in an operational mode a more structured system is required. An operations centre should be set up where image anlaysis could be done on a contract basis or have the option to book time on the system to undertake projects.